

Claims

- [1] An illumination system for producing output light having a variable angular illumination range for illuminating a display panel in a display device, comprising first and second light sources and operable selectively in a first mode in which the output light comprises light derived from the first light source with substantially no light derived from the second light source, and in a second mode in which the output light comprises light derived from at least the second light source, wherein the output light derived from the first light source has a first angular illumination range and the output light derived from the second light source has a second angular illumination range different to the first angular illumination range.
- [2] An illumination system as claimed in claim 1, wherein the second angular illumination range is wider than the first angular illumination range.
- [3] An illumination system as claimed in claim 1 or 2, wherein in the first mode the first light source is on and the second light source is substantially off, and in the second mode at least the second light source is on.
- [4] An illumination system as claimed in claim 1 or 3, wherein in the second mode the output light comprises substantially no light derived from the first light source.
- [5] An illumination system as claimed in claim 4, wherein in the second mode the first light source is substantially off.
- [6] An illumination system as claimed in any preceding claim, wherein the first light source directly produces light having an angular distribution corresponding to the first angular illumination range.
- [7] An illumination system as claimed in any preceding claim, wherein the second light source directly produces light having an angular distribution corresponding to the second angular illumination range.
- [8] An illumination system as claimed in any preceding claim, wherein the first and second light sources produce light having different respective angular distributions.
- [9] An illumination system as claimed in any preceding claim, wherein the second light source is formed from at least one organic light emitting diode.
- [10] An illumination system as claimed in any preceding claim, comprising an optical arrangement adapted to produce output light from at least one of the first and second light sources having the appropriate angular illumination range(s).
- [11] An illumination system as claimed in claim 10, wherein the optical arrangement comprises one or more optical elements which cooperate to produce output light having substantially the same power as the light received by the optical arrangement.
- [12] An illumination system as claimed in claim 10 or 11, wherein the optical ar-

rangements adapted to produce output light from at least one of the first and second light sources by use of an optical element or elements which is/are substantially non-absorbing in a visible range of wavelengths.

[13] An illumination system as claimed in claim 12, wherein the optical arrangement is adapted to produce output light from both the first and second light sources by use of an optical element or elements which is/are substantially non-absorbing in a visible range of wavelengths.

[14] An illumination system as claimed in any one of claims 10 to 13, wherein the optical arrangement is adapted to redirect light from at least one light source towards the display panel without substantially changing its angular distribution.

[15] An illumination system as claimed in claim 14, wherein the optical arrangement comprises a light guide having a light-reflecting surface adapted to redirect light from the first light source towards the display panel without substantially changing its angular distribution.

[16] An illumination system as claimed in claim 15, wherein the light-reflecting surface is substantially saw-tooth shaped.

[17] An illumination system as claimed in any preceding claim, wherein the first and second light sources emit light having substantially the same spectral profile in a visible range of wavelengths.

[18] An illumination system as claimed in any one of claims 1 to 16, wherein the first and second light sources emit light having first and second different spectral profiles respectively.

[19] An illumination system as claimed in claim 18, when dependent on claim 10, wherein the optical arrangement is adapted to produce output light having the appropriate angular range(s) in dependence upon the spectral profile(s) of the light source(s) concerned.

[20] An illumination system as claimed in claim 19, wherein the optical arrangement comprises phosphorescent material for producing output light having the second angular range from light received from the second light source.

[21] An illumination system as claimed in claim 19 or 20, wherein the optical arrangement comprises fluorescent material for producing output light having the first angular range from light received from the first light source.

[22] An illumination system as claimed in claim 20 or 21, wherein the material is transparent to light received from the other of the two light sources.

[23] An illumination system as claimed in claim 21, or claim 22 when dependent on claim 21, wherein the fluorescent material comprises three sets of fluorescent regions, the material in each set of fluorescent regions emitting a different visible colour when fluorescing, and comprising a colour filter layer for receiving light from the fluorescent material and having three sets of filter regions corresponding respectively to the three sets of fluorescent regions, the filter material

in each set of filter regions being adapted to pass substantially only the colour emitted by the fluorescent material in the corresponding set of fluorescent regions.

- [24] An illumination system as claimed in claim 21, or claim 22 when dependent on claim 21, wherein the fluorescent material is formed in a plurality of spatially-separated regions with further material disposed in between, the further material being transmissive to light received from the second light source, comprising a lens array cooperating with and receiving light from the fluorescent material to produce output light having the first angular range and cooperating with and receiving light from the further material to produce output light having the second angular range.
- [25] An illumination system as claimed in claim 24, wherein the further material is substantially opaque to light received from the first light source
- [26] An illumination system as claimed in claim 19, wherein the optical arrangement comprises a set of louvres that substantially absorb light having the first spectral profile and substantially pass or reflect/scatter light having the second spectral profile.
- [27] An illumination system as claimed in claim 26, wherein the first spectral profile comprises three dominant visible colours that are substantially absorbed by the louvres.
- [28] An illumination system as claimed in claim 26 or 27, wherein the second spectral profile comprises three dominant visible colours that are passed or reflected/scattered by the louvres.
- [29] An illumination system as claimed in claim 27 or 28, wherein the three dominant visible colours are provided by three light emitting diodes.
- [30] An illumination system as claimed in any one of claims 26 to 29, wherein the louvres comprise a dye.
- [31] An illumination system as claimed in any one of claims 26 to 29, wherein the louvres comprise a plurality of microspheres that substantially absorb light having the first spectral profile, and which are coated by a material that is substantially reflective to light having the second spectral profile and substantially transmissive to light having the first spectral profile.
- [32] An illumination system as claimed in any one of claims 18 to 31, wherein both spectral profiles are in a visible range of wavelengths.
- [33] An illumination system as claimed in any one of claims 18 to 31, wherein one of the spectral profiles is in a visible range of wavelengths and the other spectral profile is in an ultraviolet range of wavelengths.
- [34] An illumination system as claimed in any one of claims 18 to 31, wherein both spectral profiles are in an ultraviolet range of wavelengths.
- [35] An illumination system as claimed in any one of claims 18 to 34, when dependent

on claims 3 and 5, wherein the first and second light sources are provided by a single light source operable selectively to produce light either having the first spectral profile or the second spectral profile.

- [36] An illumination system as claimed in any one of claims 18 to 35, when dependent on claim 10, wherein the optical arrangement comprises a lightguide substantially transparent to light having either the first or the second spectral profile.
- [37] An illumination system as claimed in any preceding claim, wherein the output light is in a visible range of wavelengths.
- [38] An illumination system as claimed in any preceding claim when read as appended to claim 10, wherein the optical arrangement comprises a light scattering layer for receiving light from the second light source having an angular range narrower than the second angular range and producing light having a wider angular range.
- [39] An illumination system as claimed in claim 38, wherein the scattering layer is a reflective layer placed behind the second light source.
- [40] An illumination system as claimed in claim 38, wherein the scattering layer is a transmissive layer placed in front of the second light source.
- [41] An illumination system as claimed in claim 38, 39 or 40, when dependent on claim 15, wherein the light-reflecting surface is disposed in a light path between the scattering layer and the display panel, the light-reflecting surface being adapted to increase the angular distribution of light received from the scattering layer at least by refraction.
- [42] An illumination system as claimed in any one of claims 38 to 40, wherein the scattering layer is adapted to produce light having the second angular range.
- [43] An illumination system as claimed in any preceding claim, comprising a plurality of first regions arranged to output light derived from the first light source and an array of light-directing features, each feature of the array being arranged to receive light from at least one first region and to direct the received light in the first illumination range.
- [44] An illumination system as claimed in claim 43, comprising a first light guide adapted to form the first regions and arranged to receive light from the first light source.
- [45] An illumination system as claimed in claim 43, wherein each first region comprises light-scattering material for receiving light from the first light source and scattering the received light at least in part towards its associated feature of the array.
- [46] An illumination system as claimed in claim 43, 44 or 45, wherein the array of light-directing features is an array of apertures in a barrier layer substantially opaque to light from the first regions.
- [47] An illumination system as claimed in claim 46, wherein the barrier layer is

adapted to provide light in the second angular illumination range in response to light from the second light source.

- [48] An illumination system as claimed in claim 47, wherein the barrier layer is formed of fluorescent material which fluoresces in response to UV light from the second light source.
- [49] An illumination system as claimed in claim 43, 44 or 45, wherein the array of light-directing features is an array of lenses.
- [50] An illumination system as claimed in claim 49, comprising a distributed region of light-scattering material adapted to receive light from the second light source and scatter the received light at least in part towards the lens array, the lens array directing the received light in the second illumination range.
- [51] An illumination system as claimed in claim 49 or 50, comprising a plurality of second regions arranged to output light derived from the second light source, each lens of the array being arranged to receive light from at least one second region and to direct light in the second illumination range.
- [52] An illumination system as claimed in claim 51, comprising a second light guide adapted to form the second regions and arranged to receive light from the second light source.
- [53] An illumination system as claimed in any one of claims 49 to 52, wherein each of the plurality of first regions is disposed substantially at a focal point of its associated lens of the array.
- [54] An illumination system as claimed in any preceding claim, wherein the output light derived from the first and second light sources is substantially symmetrical about a same predetermined axis.
- [55] An illumination system as claimed in claim 54, wherein the output light is provided from an output surface, and wherein the predetermined axis is substantially normal to the output surface.
- [56] An illumination system as claimed in any one of claims 51 to 53, wherein the output light derived from the first and second light sources is directed in first and second different respective directions.
- [57] An illumination system as claimed in any preceding claim, in which the output light is provided from an output surface having at least one illumination region.
- [58] An illumination system as claimed in claim 57, in which substantially uniform illumination is provided from the at least one illumination region.
- [59] An illumination system as claimed in claim 57 or 58, comprising a single illumination region.
- [60] An illumination system as claimed in claim 57 or 58, comprising a set of substantially parallel, elongate illumination regions.
- [61] An illumination system as claimed in claim 60, comprising a further first light source and a further second light source for providing further output light cor-

- responding, in a first sub-mode, to the output light derived from the first and second light sources, and wherein in a second sub-mode the further output light is substantially absent, wherein the set of illumination regions is a first set of illumination regions and wherein the further output light is provided from a further output surface having a further set of substantially parallel, elongate illumination regions interposed with the illumination regions of the first set.
- [62] An illumination system as claimed in claim 61, wherein in the second sub-mode the further first light source and the further second light source are substantially off.
- [63] An illumination system as claimed in claim 60, 61 or 62, wherein the plurality of regions in a set form finger-like projections from a base illumination region.
- [64] An illumination system as claimed in any one of claims 57 to 63, wherein light is distributed to the or each illumination region using a wave or light guide.
- [65] An illumination system for illuminating a display panel in a display device, comprising a first light source arrangement arranged in first and second modes of operation to produce output light having a second-mode angular illumination range, and a second light source arrangement arranged in the first mode but not the second mode to produce output light mainly in an overlap range of the second-mode angular illumination range not including a first-mode angular illumination range contained within and narrower than the second-mode angular illumination range.
- [66] An illumination system as claimed in claim 65, wherein the second light source arrangement is adapted to produce output light having a patterned illumination intensity across the overlap range.
- [67] An illumination system as claimed in claim 66, comprising a patterned mask for producing or enhancing the patterned illumination intensity.
- [68] An illumination system as claimed in claim 65, 66 or 67, wherein the second light source arrangement comprises a first light source and an array of refracting elements adapted direct light derived from the first light source to the overlap range.
- [69] An illumination system as claimed in claim 68, wherein each refracting element is generally prism-shaped.
- [70] An illumination system as claimed in claim 68, wherein the second light source arrangement comprises a plurality of regions arranged to output light derived from the first light source, with adjacent refracting elements of the array being arranged to receive light from one of the regions and to direct the received light to the overlap range.
- [71] An illumination system as claimed in claim 70, wherein each refracting element is generally lens-shaped.
- [72] An illumination system as claimed in claim 70 or 71, wherein the first light

source arrangement comprises a second light source and a light guide arranged for receiving light from the light source, wherein the regions are disposed between the light guide and the array of refracting elements.

[73] An illumination system as claimed in claim 70, 71 or 72, wherein the regions comprise fluorescent material adapted to fluoresce in response to light from the first light source.

[74] A display device comprising an illumination system as claimed in any preceding claim and a display panel arranged to receive light from the illumination system, wherein the first mode is a private mode and the second mode is a public mode.

[75] A display device as claimed in claim 74, when dependent on claim 61, wherein the display device is a multiple view display device and wherein the first sub-mode is a single view display mode and the second sub-mode is a multiple view display mode.

[76] A display device as claimed in claim 75, or claim 74 when dependent on claim 61, wherein the display device is an autostereoscopic display device and wherein the first sub-mode is a two-dimensional display mode and the second sub-mode is a three-dimensional display mode.

[77] A display device as claimed in claim 74, 75 or 76, wherein the display panel is a liquid crystal display panel.

[78] A display device as claimed in any one of claims 74 to 77, when dependent on claim 1, wherein the first mode is temporally multiplexed with a third mode in which the output light comprises light derived from the second light source with substantially no light derived from the first light source and wherein in the third mode an image is formed on the display panel which is derived from the luminance inverse of one of the temporally-neighbouring first mode images.

[79] A display device as claimed in claim 78, wherein the second light source in the third mode is dimmer than the first light source in the first mode.

[80] A display device as claimed in claim 78 or 79, wherein in the third mode the image formed on the display panel is derived from the luminance inverse of the first mode image coming immediately before or after it temporally.

[81] A display device as claimed in claim 74, when dependent on claim 65, wherein at least the first light source arrangement is arranged to illuminate the display panel.

[82] A display device as claimed in claim 81, wherein the second light source arrangement is arranged not to illuminate the display panel.

[83] A display device as claimed in any one of claims 74 to 82, further operable to adjust the image formed on the display panel in the first and/or second mode to maintain the visual appearance, such as the colour balance and the luminance, of the viewed image when switching between modes.

[84] A display device as claimed in claim 83, wherein the image is adjusted by

altering the grey level of pixels making up the display panel.

[85] A display device as claimed in any one of claims 74 to 84, wherein at least one of the first and second light source arrangements is provided as a removeable module.

[86] An information device comprising a display device as claimed in any one of claims 74 to 85, being operable automatically to switch between the private and public modes following the performance of a predetermined operation on or at the device.

[87] An information device as claimed in claim 86, wherein the predetermined operation is the display of information classified as either public or private, which causes the display device to be switched to the public or private mode respectively.

[88] An operating program which, when loaded into an information device, causes the information device to become one as claimed in claim 86 or 87.

[89] An operating program as claimed in claim 88, carried on a carrier medium.

[90] An operating program as claimed in claim 89, wherein the carrier medium is a transmission medium.

[91] An operating program as claimed in claim 89, wherein the carrier medium is a storage medium.